

## CLAIMS

We claim:

1                   1.     A composition of hyper frequency (hf) multilayer chip inductors (MLCI)  
2 materials comprising::

3                             the major component Z-type planar hexaferrite as following:

4                              $BA_3Co_{2-x-y}Zn_xCu_yMn_zFe_{24-z-w}O_{41.3/2(Z+W)}$ ,

5                             wherein:

6                              $0 \leq x \leq 1.0$ ;  $0 \leq y \leq 0.8$ ;  $0 \leq z \leq 1.0$ ; and  $0 \leq w \leq 1.0$ ;

7                             and the minor component used as sintering aid as following:

8                              $a Bi_2O_3 + b V_2O_5 + c PbO + d B_2O_3 + e LiF + f CaF_2$ .

9                             wherein:

10                             $0 \leq a \leq 1$ ;  $0 < b < 1$ ;  $0 \leq c \leq 1$ ;  $0 \leq d \leq 1$ ;  $0 \leq e \leq 1$ ;  $0 \leq f \leq 1$ ;

11                            the weight ratio of the major component to the minor component is between 98:2  
12 to 88:12.

1                   2.     A method of preparing the hf MLCI materials as described in claim 1  
2 comprising the following steps:

3                            a) synthesizing Z-type planar hexaferrite using inorganic iron salt as raw  
4 materials:

5                                 step 1: putting  $Fe^{3+}$  iron salt into an aqueous solution before being  
6 precipitated by a ammonia solution to form precipitate  $Fe(OH)_3$ .

7                                 step 2: after filtering, washing, dissolving the fresh  $Fe(OH)_3$  precipitate

8 into hot citric acid solution at 60—800C with Fe/citric acid mole ratio in 1 to 2, obtaining a  
9 transparent solution;

10 step 3: putting cobalt, barium, zinc, copper and manganese acetate or  
11 nitrate salts in stoichiometric quantities to said solution in step 2, and then dropping an  
12 appropriate ammonia until the said solution being neutral or slightly alkaline (pH'6-8) for 2  
13 hours to give a stable sol containing the required Co<sub>2</sub>Z type hexaferrite composition;

14 step 4: drying said sol at 130-150 °C for 6— 1 Oh, and then heating-  
15 treated at a temperature between 900 to 1250°C for 6h, resulting in Z-type hexaferrite  
16 powders;

17 b) the sintering aids being mixed with hexaferrite powders by conventional  
18 ceramic route:

19 step 5: mixing the said hexaferrite powders with sintering aids oxides  
20 Bi<sub>2</sub>O<sub>3</sub>.. V2O<sub>5</sub> in a ball mill for 4 hours according the composition mentioned above during a  
21 medium of water or alcohol to form a slurry;

22 step 6: drying said slurry at 80— 120 °C, then sieving the powders ,  
23 pressing them into pellets;

24 step 7: sintering said pellets at 870—950C for 2-6h, obtaining the said  
25 hyper frequency MLCI materials.

1 3 A method of preparing the hfMLCI materials as described in claim 1  
2 comprising the following steps:

3 a) synthesizing Z-type planar hexaferrite using organic iron salt such as iron

4 citrate as raw materials:

5 step 1: dissolving iron citrate into aqueous solution, before mixing with  
6 barium, cobalt, zinc, copper and manganese acetate or nitrate salts in stoichiometric quantities  
7 to get a mixed solution;

8 step 2: dropping appropriate amount of ammonia solution into the said  
9 mixed solution to make it neutral or slightly alkaline ( $\text{pH}=6-8$ ), obtaining a steady sol;

10 step 3: drying the said sol at 130 to 150 °C for 6 to 10h, then heating  
11 treated between 900—1250°C for 6h, resulting in Z-type hexaferrite powders;

12 b) the sintering aids being mixed with hexaferrite powders by conventional  
13 ceramic route:

14 step 4: mixing the said hexaferrite powders with sintering aids oxides  
15  $\text{Bi}_2\text{O}_3$  V205 in a ball mill for 4 hours according the composition mentioned above during a  
16 medium of water or alcohol to form a slurry;

17 step 5: drying said slurry at 80—120°C, then sieving the powders ,  
18 pressing them into pellets;

19 step 6: sintering said pellets at 870—950°C for 2-6h, obtaining the said  
20 hyper frequency MLCI materials.

1 4. A method of preparing the hf MLCI materials as described in claim 1  
2 comprising the following steps:

3 a) synthesizing Z-type planar hexaferrite using inorganic iron salt as raw  
4 materials:

5 step 1: putting  $\text{Fe}^{3+}$  iron salt into an aqueous solution before being  
6 precipitated by a ammonia solution to form precipitate  $\text{Fe}(\text{OH})_3$ .

7 step 2: after filtering, washing, dissolving the fresh  $\text{Fe}(\text{OH})_3$  precipitate  
8 into hot citric acid solution at 60—80°C with Fe/citric acid mole ratio in 1 to 2, obtaining a  
9 transparent solution;

10 step 3: putting cobalt, barium, zinc, copper and manganese acetate or  
11 nitrate salts in stoichiometric quantities to said solution in step 2, and then dropping an  
12 appropriate ammonia until the said solution being neutral or slightly alkaline (pH6-8) for 2  
13 hours to give a stable sol containing the required  $\text{Co}_2\text{Z}$  type hexaferrite composition;

14 step 4: drying said sol at 130-150°C for 6~10h, and then heating-treated  
15 at a temperature between 900 to 1250°C for 6h, resulting in Z-type hexaferrite powders;

16 b) the sintering aids being added into hexaferrite powders by chemical coating  
17 route as the following:

18 step 5: dispersing the said hexaferrite powders into ethylene glycol to  
19 form a slurry, blending the sintering aids in water-soluble forms into the slurry, adjusting pH  
20 value of the mixed slurry so as to the sintering aids coating on the surface of hexaferrite  
21 particles in forms of hydroxides;

22 step 6: after drying the mixed slurry, calcining it at 700°C for 2h to  
23 form a second hexaferrite powders containing sintering aids;

24 step 7: sieving, pressing the second powders and sintering them at  
25 870~950C for 6h, obtaining the invented hyper frequency MLCI materials.

1                   5.     A method of preparing the hf MLCI materials as described in claim 1  
2     comprising the following steps:

3                   a) synthesizing Z-type planar hexaferrite using organic iron salt such as iron  
4     citrate as raw materials:

5                             step 1: dissolving iron citrate into aqueous solution, before mixing with  
6     barium, cobalt, zinc, copper and manganese acetate or nitrate salts in stoichiometric quantities  
7     to get a mixed solution;

8                             step 2: dropping appropriate amount of ammonia solution into the said  
9     mixed solution for 6 to 8 hours to make it neutral or slightly alkaline (pH=6-8), obtaining a  
10    steady sol;

11                            step 3: drying the said sol at 130 to 150 °C for 6 to 10h, then heating  
12    treated between 900~1250°C for 6h, resulting in Z-type hexaferrite powders;

13                   b) the sintering aids being added into hexaferrite powders by chemical coating  
14    route as the following:

15                            step 4: dispersing the said hexaferrite powders into ethylene glycol to  
16    form a slurry, blending the sintering aids in water-soluble forms into the slurry, adjusting pH  
17    value of the mixed slurry so as to the sintering aids coating on the surface of hexaferrite  
18    particles in forms of hydroxides;

19

20                            step 5: after drying the mixed slurry, calcining it at 700 °C for 2h to form  
21    a second hexaferrite powders containing sintering aids;

22 s step 6: sieving, pressing the second powders and sintering them at  
23 870~950°C for 6h, obtaining the invented hyper frequency MLCI materials.